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THE EVOLUTION OF MLEARNING AND LEVERAGING TECHNOLOGY INTO EDUCATIONAL PRACTICES

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Abstract. *This paper presents an overview of a multi-agent platform designed to facilitate the effective incorporation of mobile devices into educational practices, through the delivery of contextualized and personalized services. Details on the contextualisation of delivered service content together with supporting mechanisms are presented. This contextualization functionality enables the system to adapt in response to varying operating environments, and to the service delivery modes dictated by, or matched to, the personal context of the user.*

Keywords: InfoStations, mLearning, contextualised & personalised services, Multi-Agent System (MAS)

1. INTRODUCTION

Technology, in many different forms, has revolutionized the everyday lives of people all over the world. There are very few aspects of our lives which have not evolved to incorporate various types of technology. In particular, the adoption of 3G capable mobile devices has allowed people instantaneous access to treasure trove of resources available across the Internet and through various apps. However, one realm which has been quite slow to evolve to incorporate mobile technologies is that of educational practices.

eLearning, which began with the introduction of computer-based training (CBT) [1] within corporate environments, was seen as a method of replicating the traditional educational setting. With the evolution of the Internet, the utilization of eLearning proliferated throughout the world, revolutionizing the delivery of educational materials. As the technologies underpinning the Internet itself have evolved and matured, so too have the strategies for applying these technologies to meet educational purposes as part of a stand-alone approach, as is the case with distance learning, as well as within more traditional educational environments. The need for a compromise between the conventional face-to-face sessions and online learning led toward a new approach to teaching and learning (T&L), a so called hybrid or blended learning [2]. Blended learning represents a fundamental re-conceptualisation and re-organisation of the T&L dynamic, starting with various specific contextual needs and contingencies (e.g., discipline, developmental level,

and resources) [3]. As mobile devices have become the dominant medium of access to the Internet, particularly with the advent of smartphone technology, what has commonly been known as eLearning, is enhanced by the new communicative potential that is mobile eLearning (mLearning), which opens up new avenues in the pursuit enhancing blended learning environments. The utilization of mobile technologies can enable education institutions to extend their reach, no longer constrained by location or time, but offering true 'anywhere-anytime-anyhow' learning [4]. Therefore, the platform detailed within this paper was designed with one main goal in mind: the effective incorporation of mobile devices into the spheres of education. Essentially, we put forward that, by finding more effective means of embracing mobile technology, more effective means of instruction can be pursued.

The rest of this paper is organized as follows. Section 2 describes the evolution of mLearning and the advent of the 'Digital Native'. Section 3 outlines the composition of the platform, detailing the main components involved in facilitating contextualized user access to services, as well as detailing the mechanisms incorporated into the system which facilitate the contextualization of services, highlighting the use of both user- and service profiles and how service providers utilize these profiles effectively. Finally, Section 4 concludes the paper.

2. EVOLUTION OF MLEARNING & DIGITAL NATIVES

In Ireland, the shift towards the delivery of more blended educational environments, which incorporates both traditional and online educational practices, has assumed even greater importance, due, in no small part, to the large expansion of the Irish third-level education system over the past twenty years. Indeed, this expansion has continued for a variety of reasons. The Irish government's expansion policy on higher education indicated a goal of 72% of the 17-18 year old cohort entering higher education by the year 2020 [5]. Currently over 65% of school leavers are entering higher education [6], and this expansion has become far more rapid than expected, due in no small part, to high levels of unemployment in Ireland and the population as a whole turning to further education and re-training in order to become more employable. While expansion within this system may be viewed as progression and development, it also leads to a very diverse cohort of students within the third-level classroom. This diversity and wide range of mixed ability students leads to further challenges and issues for third-level educators. Student retention and attrition have become hugely problematic, particularly in science, engineering and mathematics based courses. This diverse group of students requires a thorough re-evaluation of traditional T&L strategies utilized in the third-level classroom. The traditional didactic 'jug and mug' T&L model is no longer appropriate for many third-level classrooms, as the wide variety of mixed ability students enter the lecture hall with their own prior knowledge, experiences and learning styles. In the last number of years the majority of the young students entering both secondary and tertiary education can be said to be born of a digital

era, or “Digital Natives” [7]. These students have grown up entirely in a connected world, where the use of technology, in various forms, is a central part of their lives. These millennial and post-millennial students [8], have been characterized by the desire to be more ‘connected’, and show a preference for social interaction in both social and study environments. With technology, and in particular, mobile technology so engrained in these students’ lives, asking them to step into a learning environment, still operating in practices unchanged in over a hundred years, risks not only failing to engage these students, but rather pushing them to disinterest [9]. Likewise, as more and more people return to education, very often in an attempt to re-skill, adapting to modern educational environments and practices can be a daunting prospect.

The utilization of eLearning in a blended learning environment is well suited to meeting the varying needs of such a diverse student cohort, aiming at replacing old-fashioned time/place/content predetermined learning with a just-in-time/at-work-place/customized/on-demand process of learning [10]. A blended approach enables educational program developers to augment and enhance their existing programs through the incorporation of a huge variety of media, available through the Internet. While many studies have advocated the continued development of blended learning environments, they have also identified pitfalls which must be avoided in order to deliver an effective learning experience. In particular, losing the attention of the students to the novelty of new approaches and technological media must be limited as much as possible, with the focus being maintained on the presented learning materials. The technology must, in essence, act as a transparent medium through which the educational materials may be delivered in a more effective manner. Key to an enhanced student experience is a tool that is capable of meeting both the students’ and the lecturers’ needs and one that is reliable and easy to use [3]. According to a recent report [11], 4.55 billion people worldwide will use a mobile phone in 2014, with mobile-phone penetration rising from 61.1% to 69.4% of the global population between 2013 and 2017. This illustrates how significantly the utilization of mobile devices has become entrenched into societies throughout the world. This utilization of mobile technologies represents a huge resource that, for the most part, has been left untapped as regards the delivery of learning content within educational institutions. Employing the student’s own mobile devices, and indeed interacting with these technologies on a daily basis, enables them to experience the benefits of an enhanced blended learning environment, without having to contend with the novelty of a new technology, or build up a familiarity with these technologies. With an ever diversifying student cohort entering tertiary education, the presented approach gains even greater importance. It is imperative that educational processes cater for all students. The system presented in this paper seeks to ensure that every student has equal access to resources, and that no student is left unable to enjoy the educational benefits of the services provided.

3. INFOSTATION ARCHITECTURE FOR CONTEXTUALISED AND PERSONALISED MLEARNING

The core goal of the system detailed in this paper has been to seek out a means to effectively incorporate mobile devices to a much greater degree within educational environments, and as such facilitate a suite of services designed to enhance traditional educational practices. Upon investigation, one particular initiative demonstrated great potential for the facilitation of these goals. The InfoStation design paradigm was originally proposed to provide "many-time, many-where" [12] wireless data services, with geographically dispersed wireless nodes providing 'islands of connectivity' to these services. The original InfoStation architecture, proposed by researchers at the Wireless Information Network Laboratory (WINLAB) at Rutgers University, was designed to address shortcomings in the delivery of data services within 2G environments, such as low bandwidth and bit rate, battery limitations, cost, etc. While the system detailed in this paper does not attempt to create a cellular InfoStation system to rival the deployment of 3G and 4G, it does seek to build on the work undertaken as part of previous InfoStation projects, to deliver localised, contextualised and personalised mobile services within particular application domains, in particular to enable registered users to access a range of mLearning services through a distributed network of InfoStations, situated at different locations throughout a university campus (e.g., library, lecture theatres, laboratories, etc.). As discussed previously in [13], this architecture involves various entities operating within a three-tier structure as depicted in Figure 1: user mobile devices, InfoStations, and an InfoStation Centre. Within these three tiers, functionality is dispersed with various elements cooperating to facilitate users with contextualized service access.

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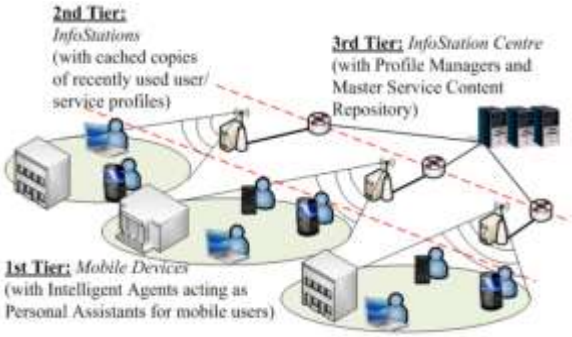

Figure 1. Three-tier InfoStation-based network architecture

Each mobile device houses a light-weight personal assistant (PA), which facilitates the user's interactions with the system and the access to the various services. Each InfoStation facilitates the establishment of connections to mobile

devices which enter within its range, and houses a cache of recently accessed user- and service profiles, as well as a repository of available services. The InfoStation Centre, which stands at the core of the system, is concerned with the creation and updating of content throughout the system. From this central point, service updates can be propagated across the system. Any user- or service update, which the InfoStation Centre receives, is distributed throughout the system, so as to ensure each InfoStation has access to the most up-to-date information. Whilst within range of an InfoStation, clients may gain access to various contextualized and personalized mLearning services and resources distributed throughout the system architecture. Due to the inherent mobility of the target audience, as well as the spatially discontinuous nature of the connectivity to the InfoStations, agents operate not just on board the InfoStations and the InfoStation Centre but also within the users' mobile devices [14, 15]. These agents each function autonomously in order to satisfy any user service requests they may encounter, while in or out of contact with other agents based throughout the tiers of this architecture. In order to build this Multi-Agent System (MAS), a proper development framework was required, preferably as part of an open-source initiative. The Java Agent Development (JADE) framework, developed by TILAB [16], was adopted to support the implementation of this MAS. The JADE framework simplified the MAS design and implementation through the provision of a defined set of services and management tools in addition to the run-time library and agent programming library. Within the InfoStations and the InfoStation Centre, a set of interoperating agents, each of which fulfilling various essential roles necessary for the system management, communicate by passing ACL messages [17]. These agents take responsibility for establishing a client-server cross-platform connection, the conveyance of context information, the delivery of adapted and personalised service content, etc. Figure 2 illustrates the main components within this system, including the main agents involved in the service delivery, and the data persistence mechanisms incorporated into the system.

The connection advisor agent (CAAgent) performs the role of identifying the context of the user making the request for services from an InfoStation. When the user selects a particular service s/he wishes to access, the CAAgent is tasked with supplying the location of the relevant service content to the user's PA, installed on the user's mobile device. The list of applicable services is harnessed from the service database. Within this system implementation, the two main mLearning services offered from the InfoStation relate to the delivery of contextualised lecture content (mLecture) and testing materials (mTest). With this in mind, two agents are tasked with delivering these services to requesting users – the WALL next generation agent (WNGAgent) and the mTest delivery agent (mTDAgent). The primary task assigned to the WNGAgent is to facilitate the delivery of the requested mLecture content to the user's PA. This process involves discerning the capabilities of the requesting device, particularly the file types and mark-up supported, and then adapting the requested content to suit the operating environment on-board the requesting device. The mTDAgent is charged with the

delivery of mTests to requesting users. The mTest service [18] provides a means to evaluate the students acquired knowledge and provide feedback, making the students aware of their progress in the assimilation of the presented module content, and highlighting any knowledge or skills deficit they may need to address. This is achieved through the delivery of various forms of test content to the PA, as illustrated in Figure 2.

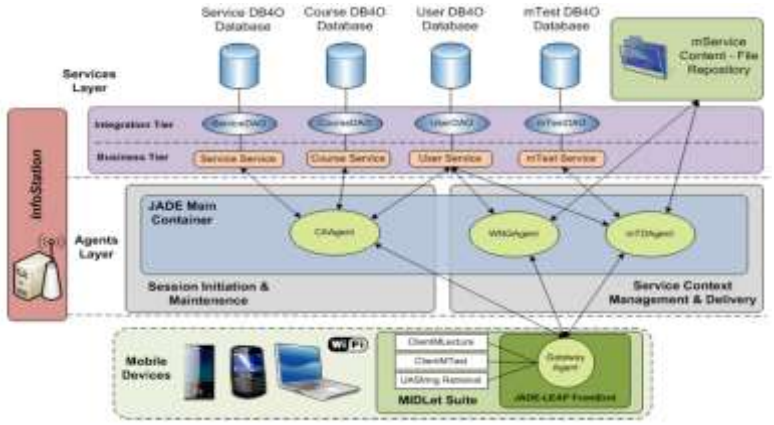

Figure 2. InfoStation-based multi-agent environment

In the current market, the diversity in capabilities of modern mobile devices and supported platforms mirrors the diversity in the personal characteristics of the individuals themselves. Indeed, with mobile technology playing such an inherently integral role in this mLearning system, the device capabilities and features may have a major bearing on not only service delivery, but also on the overall learning experience of the system users. The agents operating within this architecture harness and utilise the capability and preference information (CPI) of the requesting device through the Wireless Universal Resource File (WURFL) [19]. This capability database, and its associated application programming interface (API), enables service facilitators / adaptation entities to generate a specification of the capabilities and features for any requesting device based on a user agent string, which specifies some basic details about the device. While it is essential that the context of the user's mobile device be taken into account when adapting presented services, the user's own personal context needs also to be considered when delivering these services. As discussed previously [13], all user information is stored within a database for objects (DB4O) [20]. Each user instance is composed of a number of simple string objects such as the userName, password, etc. with each piece of information playing a vital role in the contextualisation and delivery of services. Figure 3 illustrates the user profile composition.

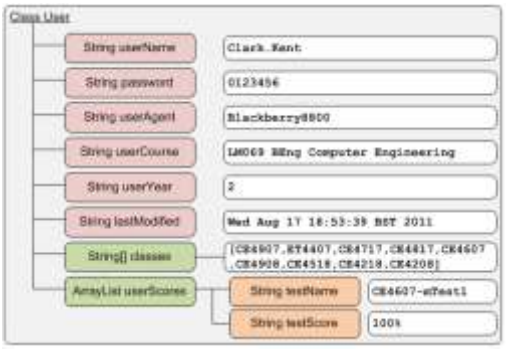

Figure 3. User profile composition

4. CONCLUSION

A multi-agent based platform designed to facilitate the effective incorporation of mobile devices into traditional educational settings has been presented in this paper. The evolution of mLearning and the advent of the 'Digital Native' have been discussed highlighting the need for more effective and modern approaches to education delivery. The composition of the platform, including the main components involved in facilitating contextualised user access to services has been detailed. The mechanisms incorporated into the system, which facilitate the contextualisation of services, have been highlighted at the end.

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